GROWTH AND THE LONG SWING IN THE JAPANESE ECONOMY*

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I *The Problem*

According to income estimates by Y. Yamada and K. Ohkawa, the long-term growth rate of real national income in Japan was around 4–5% per annum during the prewar period.[1] Evaluations of this growth rate have been concerned mainly with the average rate over a long-period, say fifty years, rather than its fluctuation. This is because of the convictions of analysits that the long-term income estimates have statistical weaknesses which, though not an obstacle to evaluation of the long-run growth rate, make it difficult to evaluate the short-run or long-run cycles of real income. Another difficulty is that, in deriving a real income series, the wholesale price index was often used as a deflator. However, its oscillations are particularly sharp compared with an estimated price index for final commodities. Therefore, real income sometimes rises in depression and declines in boom when the wholesale price index is used. Moreover, the number of items used in constructing the index is less for the prewar period than for the postwar period, another factor making for sharp oscillations of the deflator.

Nevertheless, it is possible to break through this data bottleneck and ascertain the long-cycles of the real income growth rate, although it is still difficult to clarify short-run cycles. Fortunately, Saburo Yamada has recently provided a long-term cost-of-living index estimate, so a weighted average of the wholesale price index and the cost-of-living index can be used as an alternative price deflator.

Thus, the problem is to (1) define and analyze the long swings of the real income growth rate, checking them by various reference series, (2) study the variations in the growth rate between the "take off" stage before 1900 and the period after 1900, industry by industry, and (3) consider the role of expansion of foreign trade in Japanese economic development, particularly with reference to secular deterioration in the terms of trade.

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* This is a part of a long-term study of the quantitative growth of Japan, financed in part by the Rockefeller Foundation, undertaken at the Institute of Economic Research, Hitotsubashi University. Just at the time this paper was published in Japanese, I had the opportunity of reading Prof. K. Ohkawa's paper (unpublished), "The Pattern of Japanese Long-term Economic Growth" written at Berkeley. In that paper, he develops some ideas on the long swing of the Japanese economy, but it is quite different from mine in terms of measurement, hypothesis and construction.

[1] Yuzo Yamada, *Nippon Kokumin Shotoku Suikei Shiryo* (A Comprehensive Survey of National Income Data in Japan), Tokyo, 1951; Kazushi Ohkawa and others, *The Growth Rate of the Japanese Economy since 1878*, Tokyo, 1957.

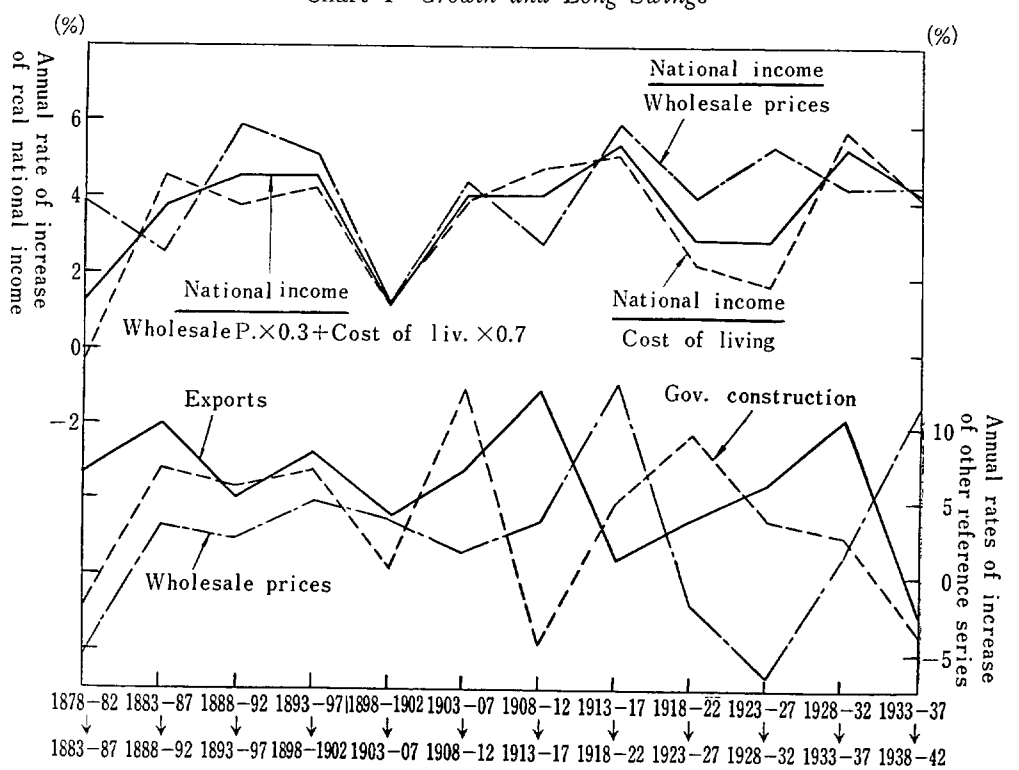
II *Long Swing in Prewar Japan*

The so-called "Kondratieff Waves" relate mainly to the long waves of the wholesale price index the duration of which range from thirty to sixty years. However, the long swings computed here are somewhat different. They are the cycles of the real income growth rate. In this sense, the Japanese counterprart of the "Kuznets cycle"[2] will be determined. In the United States, the length of the Kuznets cycle is around twenty years. Is this also true in the case of prewar Japan?

As a national income deflator, the weighted average of the wholesale price index and the cost-of-living index, with the relative weights of 3:7 was used. In view of the composition of national expenditure, one might like to give more weight to the wholesale price index, but its bias in the direction of crude and semi-manufactured raw materials, and the small munber of commodity items used led to adoption of the above weighted average, here. As the money national income series, Ohkawa's estimate was used.

The computational process and the sources for basic data are indicated in Table 1.

Chart 1 *Growth and Long Swings*



[2] S. Kuznets, "Long-term Changes in the National Income of the United States of America since 1870", *Income and Wealth*, Series II.

Table 1. *Cycles of the Rates of Change in Income and Prices*

A C, F, I=Unit: ¥ million

	A Money national income	B Cost of living index	C $\frac{A}{B}$	D Annual rate of increase of C	E Wholesale price index	F $\frac{A}{E}$	G Annual rate of increase of F	H Aggregate** defiator $\left[\begin{matrix}B\times0.7\\+E\times0.3\end{matrix}\right]$	I $\frac{A}{H}$	J Annual rate of increase of I	K Annual rate of increase of A	L Annual rate of increase of E
1878 - 82	667	*26.69	2,499	%	41.7	1,600	%	31.02	2,150	%	%	%
1883 - 87	607	24.41	2,487	−0.10	31.6	1,921	3.80	26.41	2,298	1.34	−1.87	−5.40
1888 - 92	809	25.99	3,113	4.59	37.1	2,181	2.59	29.22	2,769	3.80	5.91	3.26
1893 - 97	1,203	32.18	3,754	3.81	41.7	2,897	5.84	34.83	3,468	4.61	8.35	3.36
1898-1902	1,978	42.83	4,618	4.23	53.1	3,725	5.16	45.64	4,334	4.56	10.36	4.95
1903 - 07	2,522	51.21	4,925	1.30	63.7	3,959	1.23	54.63	4,617	1.27	4.95	3.71
1908 - 12	2,366	56.20	5,989	3.99	68.5	4,914	4.42	59.53	5,654	4.14	5.94	1.64
1913 - 17	4,593	60.61	7,586	4.84	81.2	5,663	2.88	66.40	6,925	4.14	6.44	3.46
1918 - 22	11,385	116.64	9,761	5.17	150.4	7,570	5.98	126.02	9,034	5.46	19.88	13.12
1923 - 27	12,946	117.80	10,990	2.40	139.6	9,274	4.14	123.53	10,476	3.00	2.60	−1.94
1928 - 32	12,132	100.93	12,020	1.81	100.0	12,132	5.52	100.00	12,132	2.98	−1.29	−6.46
1933 - 37	16,161	101.24	15,963	5.84	107.4	15,047	4.40	102.44	15,776	5.40	5.90	1.44
1938 - 42	34,547	176.99	19,519	4.10	184.6	18,715	4.46	178.13	19,394	4.22	16.41	11.43

Sources: Money national income: Ohkawa and others, *The Growth Rate of the Japanese Economy Since 1878*; Cost-of-living index: Saburo Yamada, "Long-term Cost-of-Living Index from the Early Period of the Meiji Era to World War II", (mimeographed in Japanese, Rockefeller Project B. 36 of the Inst. of Econ. Research, Hitotsubashi University).

Notes: * S. Yamada does not give a cost-of-living index figure for 1878. Thus, it is estimated from the change in the wholesale price index from 1878 to 1879.

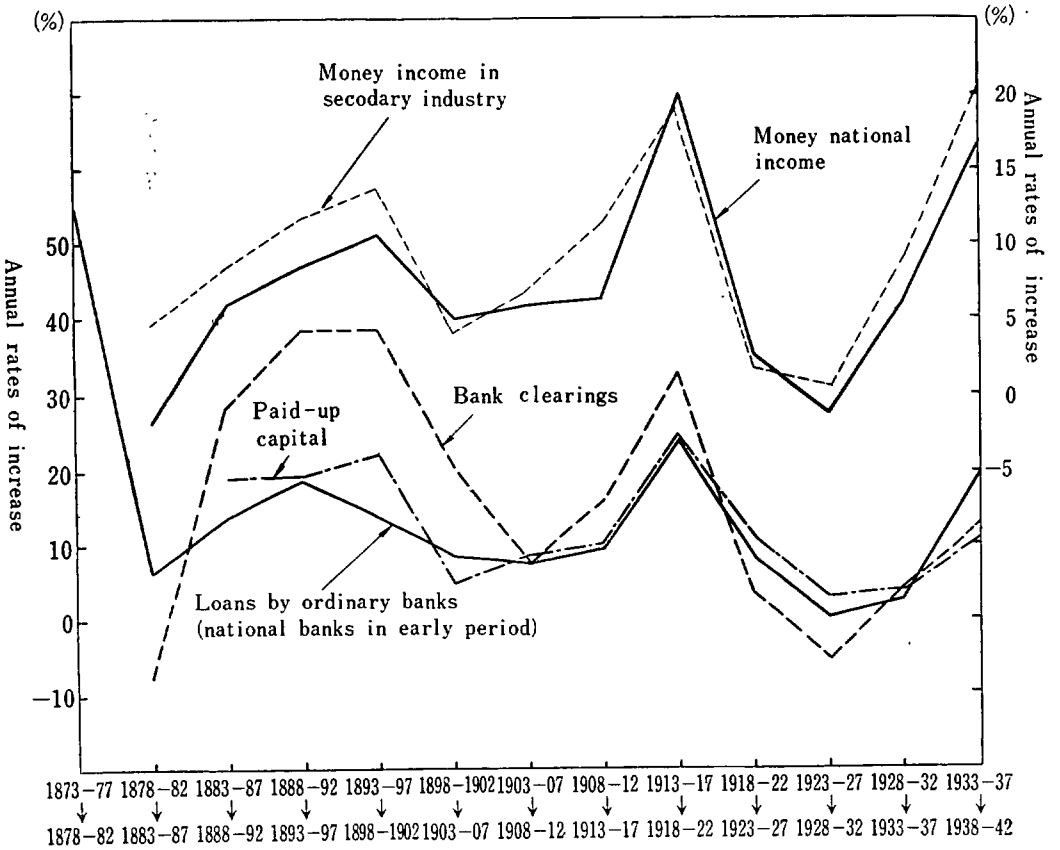
** As S. Yamada's index (B) is 1934-36=100, and the wholesale price index (E) is 1928-32=100, the geometric average of the two was computed after the former was converted to a 1928-32 base.

Growth rates for five year averages of real income were computed. This might not eliminate the influence of shorter (say, Juglar's) cycles, but the cycles derived are almost free from such influence. Moreover, compared with a tentative computation using ten year averages, the temporal location of cycles is much more determinate. For this table, three kinds of real income growth rates were computed using three different deflators: the wholesale price index, the cost-of-living index and the aggregate deflator.

The three kinds of real income growth rates are depicted in the upper part of Chart 1. In spite of the fact that, in the case of the growth rate deflated by the wholesale price index, the trough of the 1930's disappears, in terms of the other two growth rates, the existence of such a trough is very clear. Thus, the existence of a long swing, the duration of which is between 20 and 25 years is ascertained.

As shown in the lower part of Chart 1, the rates of change in the volume of exports and government construction roughly parallel the growth rate of real income until the 1900's. Thereafter, however, government construction behaves in a rather inverse (contra-cyclical) way, and exports do not precisely coincide with the income growth rate. The rate of change of wholesale prices is similar to that of real income, except that the former's

Chart 2 *Long Swings of the Rates of Increase in Money-term Magnitudes*



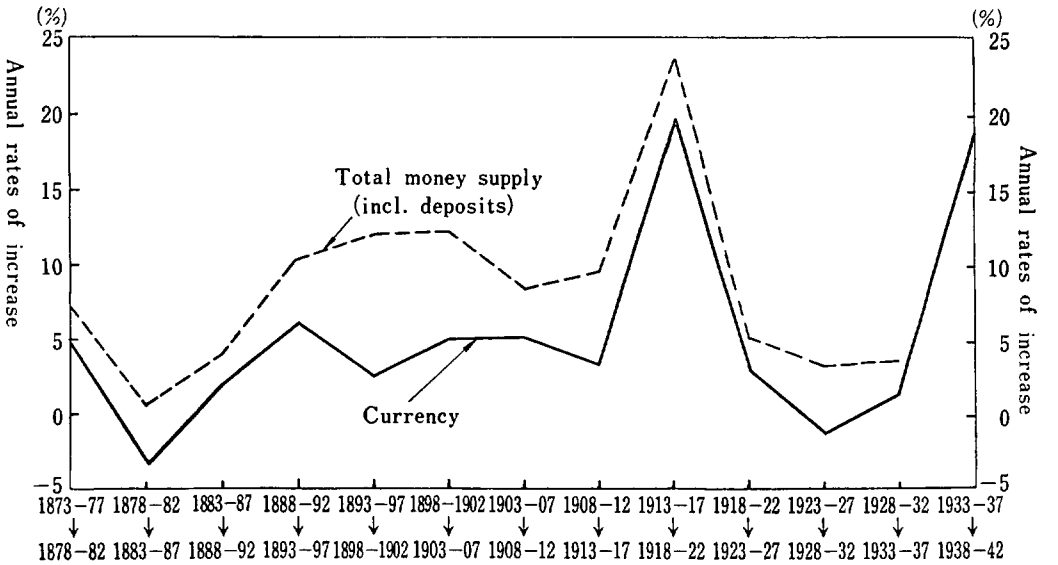
trough lags behind that of the latter in the second downswing in the early 1900's. Therefore, the long swing patterns of other series must also be examined.

In chart 2, the long swings of the rates of change in five other series, *in money terms*, are depicted. As these are in money terms, they are sharply pointed in the World War I period, when price rose steeply. With this exception, their patterns of long swing are similar to that of the real income growth rate. The second trough in some series lags behind that in the real income growth rate, but the second trough in the long swing of paid-up capital coincides with it very nicely.

Although some doubt remains concerning the location of the second trough (1903–07 or 1908–12), from the behavior of the rates of change of such series as bank clearing, loans, and paid-up capital, the existence of a Kuznets cycle (20 to 25 years) is roughly established.

Incidentally, Chart 3 indicates the cycle of the rate of change in money supply. This almost corresponds with the rate of change in wholesale prices shown in Chart 1. In this case, total money supply is defined broadly, including time deposits, and involves "Hansatsu" (notes issued by the feudal clans) in the early Meiji period. This series is from Shozaburo Fujino's[3] estimate, which has been converted from the original annual figures to 5 year averages.

Chart 3 *Long Swing of the Rate of Increase of Money Supply*



[3] Shozaburo Fujino, "Estimates of Money Supply, Marshallian k, and Income Velocity for 1874–1940," (Capital Accumulation Studies, 16 of the Institute of Statistical Research), mimeographed (in Japanese).

III *Explanation of the Long Swing*

According to Chart 1–3, the first trough of the long swing is around 1883–87. This includes the years 1881–86, when a drastic deflationary policy was enforced by Finance Minister Masayoshi Matsukata to wipe out an excess of paper notes issued during the preceding civil war (the "Satsuma Rebellion").

It is clear that, before 1883–87, the growth rate was higher, for the rate of increase of bank loans (Chart 2) was much higher and the rate of increase of money supply (Chart 3) was also higher for 1873–82. Also, developments during this period confirm this view. First, in 1870, a flotation of foreign loans of £1 million was used for the construction of railroads from Tokyo to Yokohama and Osaka to Kobe. In 1881, the railroads were extended to a total length of 138 miles. Second, during this period, various government factories were established, paving the way for industrialization. These included the Tomioka Silk Reeling Mill in 1872, the Senju Woolen Mill in 1876, the Aichi Spinning Mill and Hiroshima Spinning Mill in 1881, the Fukagawa Cement Factory in 1875, and the Shinagawa Glass Factory in 1876. Third, the "Satsuma Rebellion" broke out in 1877, which, together with the beginning of industrialization, caused a hyperinflation which accelerated the mushroom growth of small scale firms.

During the period 1881–86, Finance Minister Matsukata succeeded in reducing the amount of paper notes in circulation by about ¥40 million by curtailing government expenditure and increasing tax revenues. Because the total amount of government and bank notes in circulation in 1881 was about ¥153 million, this meant a 26% reduction. Due to a 30% decline in wholesale prices and a 50% decrease in the price of rice, farmers and small scale firms suffered greatly during this period. This period was the first trough of the long swing in Japan.

As a result of Matsukata's deflationary policies, many small scale firms were liquidated, the interest rate declined and the accumulation and concentration of capital were accelerated. Further, exports were greatly stimulated and the excess of imports were wiped out. Thus, the upswing in the long cycle began from the end of this period and continued until the early 1900's when the second trough in the long cycle occurred. The first so-called capitalistic crisis in Japan occurred in 1890, but it did not affect the shape of the upswing in the growth rate.

The period from the end of Matsukata's policy of deflation to the early 1900's constituted the so-called "take-off" stage, in which there was rapid increase in the tempo of Japanese industrialization. First, there was a tremendous expansion of the railroad network, and growth in electric power output and shipping. From 1881, when the Japan Railroad Company was established, until 1891, the number of railroad companies receiving franchises increased to 150, and the length of lines operated by private railroads in 1892 totaled 1,322 miles, more than double the 557 miles of government railroads in the same year. After 1892, when the Railroad Act was passed, the Government also launched upon a railroad expansion, national lines in operation totaling 1,500 miles in 1905, though some of this increase was due to government purchase of private lines. Thus, private railroad construction and expansion of national railroads were important causes of rapid expansion in this period.

Since the establishment of the Tokyo Electric Co. in 1887, the use of electricity remarkably increased, and spread throughout the country (electric power; 1,500 kw in 1890, 80,239 kw in 1903). After the appearance of the Osaka Shosen Kaisha (O.S.K.) in 1884 and the Nippon Yusen Kaisha (N.Y.K.) in 1885, shipping extended its routes to foreign countries and the number of ships increased each year. Under the protection of a subsidy and other government favors as a result of the Shipbuilding Act and the Navigation Promotion Act, the three large ocean lanes (the European, American and Australian) were opened.

Second, before Japan adopted the gold standard in 1897, it had been on a silver standard. The world-wide tendency toward decline in the price of silver, had the same effect upon exchange rates between Japan and countries under the gold standard as continual exchange devaluation. This resulted in rapid expansion of exports.

Third, Japan acquired the sum of ¥365 million in reparations from China after the Sino-Japanese War of 1894–95. This was about one fourth of the national income at that time, and financed expansion of the army and navy; establishment of the Yawata Iron Mill; extension of railroad, telegraph and telephone services; and government monopoly enterprises, as well as the adoption of the anticipated gold standard. It was also during these years that the Hypothec Bank of Japan, the Industrial Bank of Japan, the Bank of Taiwan, and other special banks appeared on the scene. Thus, the huge amount of reparations should be regarded as having played a most important supporting role in the "take-off" stage during the Meiji era.

After the above mentioned upswing, there was a second trough in the early 1900's for which the following were important causes. First, economic activity during this period seems to have followed a kinked curve. The advance of such activities as railroads, and cotton thread production tapered off about this time. Second, in view of the Kondratieff waves in the world-wide sense, the declining tendency of prices reached bottom in this period. Third, by adopting the gold standard, Japan lost the stimulating effect upon exports of the secular, relative decline of the price of silver. This, for some time, made domestic prices high relative to those of countries on a silver standard. Thus, exports of cotton goods to China, for example, were depressed. As a result, despite the Japanese tendency toward expansion during the Russo-Japanese War (1904–5), there were several crises and a persistent import surplus after 1897. After the Russo-Japanese War, the Government attempted to solve these difficulties by floating foreign loans of about ¥800 million, as well as by heavy taxation. Even after the crisis of 1907, the Katsura Cabinet, which was formed in 1908, was forced to adopt a retrenchment policy and to make effort to strengthen economic stability.

In Chart 1, the second trough of the long swing of the real income growth rate is around 1903–07. The same holds true for real government construction, volume of exports and paid-up capital. However, the next period, 1908–12, is the trough for wholesale prices, bank clearings, and money supply. This indicates that prices and finance remained depressed despite expansion of the economy. Domestic investment and exports increased in 1908–12, raising the volume of production. The accompanying deficit in the balance of payments was supported by flotation of foreign loans amounting to about ¥2 billion. Of this amounts ¥800 million was used for Russo-Japanese War expenditures, the remainder for expansion of industry. These loans interrupted a decline in prices to some extent and raised the growth rate. However, after 1910, the outflow of gold and silver reached enor-

mous proportions, leading to monetary contraction and a great decline in prices in 1914.

The succeeding upswing of the long cycle was caused by the outbreak of World War I and, as shown in Chart 1, the downswing ended in 1928–32, during the great world depression. Although 1928–32 becomes the third trough according to Chart 1, the annual real income growth rate declines from 4–5% to about 3% in 1923–27, and the third downswing is much longer than the second.

Briefly, the reasons the 1920's witnessed the third downswing of the long cycle can be stated as follows. Japan's balance of payments shifted from a deficit to a surplus owing to the outbreak of World War I, recording an export surplus of ¥2.8 billion for 1915–18. This naturally brought about a boom. However, Japan was in an unstable condition long after the War. The boom continued only a short time after the War, collasping in 1920 owing to the financial crisis caused by the increasing import surplus and monetary contraction. Even after the crisis, the economy was in a stagnant condition due to the comparatively high domestic price level, an import surplus and the efflux of gold. Nevertheless, easy financing for accumulation of inventories and spending for reconstruction after the Kanto earthquake (1923) continued. Thus, the volume of production increased mainly because of brisk construction activity, but prices continually tended to decline. In 1927, a financial crisis occurred as a consequence of the post-war easy money policy. In 1928, the Hamaguchi Cabinet announced that in January, 1930, it would lift the gold embargo which had been in effect since 1917. In preparation for this step, a policy of austerity was pursued. However, because this policy was enforced during the world depression and at the old par, there was a huge (¥700 million) specie outflow in 1930–31, and the attempt failed.

The following upswing is very easy to explain. It was caused by an increase in military expenditures and by a sharp expansion of exports made possible through exchange devaluation in 1932.

To summarize: in the long swing as viewed from the stand point of the real income growth rate cycle, the upswing has always occurred during a period of war. On the one hand, the acquisition of reparations after the Sino-Japanese War and the immense accumulation of foreign exchange during World War I, led the economy into prosperity, lifting the level of foreign trade. On the other hand, in the trough of the long swing, there have always been severe monetary contractions—e.g., the Matsukata deflation, the adoption of the gold standard, the lifting of the gold embargo—in association with balance of payment difficulties. As a consequence, the terms of trade were seriously and adversely affected—a 31% decrease in the terms of trade for 1907–13 and a 40% decrease for 1931–37.

It would be nonsensical to attempt to establish some cyclical law to which the economy is subject in the long swing. Rather, the aim here is to determine the main factors which caused fluctuations in the process of rapid economic expansion since the Meiji era,—the secular prosperities and the three big liquidation processes. Most striking in this analysis are the roles of war and monetary contraction in the development of the Japanese economy.

As is generally noted, the Japanese economy exhibited a high secular growth potential, but it was also highly susceptible to wide fluctuations (in the sense of fluctations in the growth rate). The troughs of the long swing should also be noted as structural turning points. The "take-off" process started after the first trough. It is generally recognized that Japan's industrial revolution, centering on the cotton textile industry, was established

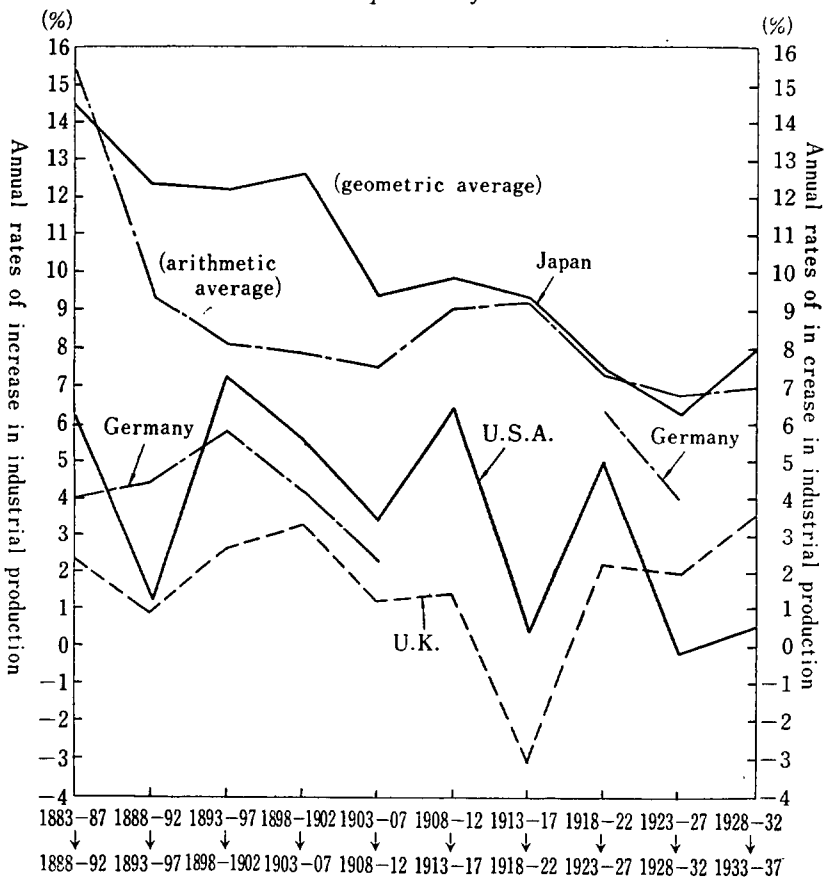
about the time of the second trough in the early (1900's). From the third trough (during the world depression), the importance of heavy industry drastically increased. Thus the process of economic growth cannot be expressed simply by a straight line or exponential curve. Although care should be exercised in applying such a purely mechanical device, the fact that the Japanese economy had a long swing of 20–25 years duration should be taken into consideration in any future projection of economic growth.

IV *Internal Structure of the Long Swing*

The long swing of the real income growth rate has been discussed. Next, the growth rates of industrial production and various individual commodities will be examined. Chart 4, presents comparison of the growth rates of industrial production in the U.S.A., U.K., Germany and Japan.

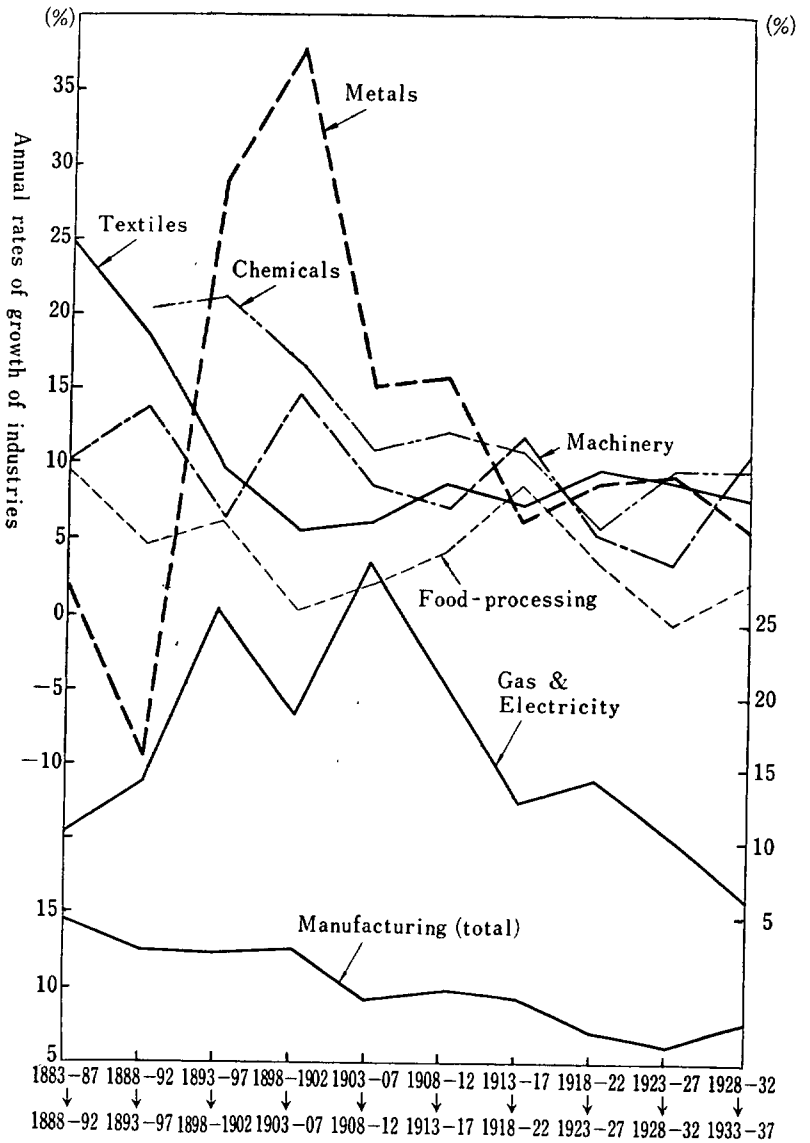
Contrary to expectation, the industrial production growth rate cycle for Japan is

Chart 4 *International Comparison of Industrial Growth Rates*



not so clear as the real income growth rate cycle. It should also be noted that, in the case of Japan, there is a difference between the arithmteic average and the geometric average index of industrial production, which affects the computation of industrial growth rate. In the original index of industrial production estimated by the Nagoya Commercial College, the geometric average method was used. The arithmetic average was computed by the author using individual industries (e.g., metal, chemical, textile), not commodities, as the basis. In both cases, the industrial growth rate turns upward just when the real

Chart 5 *Changes in Industrial Growth Rates By Subsector*



income growth rate is in its second trough. The reason for this will be explained when an analysis by industry is given.

Chart 4 shows that, while the industrial growth rates of the United States and U. K. rise and fall, embodying the influence of a Juglar cycle, the industrial growth rate of Japan seems to be quite free from such influence, regardless of whether the arithmetic average or the geometric average is used. This might be because, in Japan, where the upward trend was very sharp, the influence of a Juglar cycle upon the five-year average rates of increase of industrial production and real income was much weaker than in other advanced countries.

The unexpected difference in the growth rate, depending on whether the arithmetic average or the geometric average is used, can be explained as follows. When the geometric average is used, individual series of production are averaged after they have been reduced to logarithms. Thus, a commodity or industry with a relatively higher rate of increase has a relatively greater effect on the total index of production in this method. However, when the arithmetic average is used, only the absolute size of changes is relevant.

In Chart 5, the rate of growth of production in various industries is shown, using the Nagoya index. Although the growth rates of food-processing, textile, and chemical industries behave as expected, metal industry output shows a remarkably high rate of increase in 1903–07, when the second trough in the long swing of the real income growth rate occurs. This was due mainly to the Russo-Japanese War. To a lesser extent, the machinery industry was subject to the same influence. When the geometric average index is used, this influence is sensitively reflected in the total index.

These relationships can be examined in detail by commodity; the outputs, exports and imports of cotton goods, silk, pig iron and steel are shown in Charts 6–8.

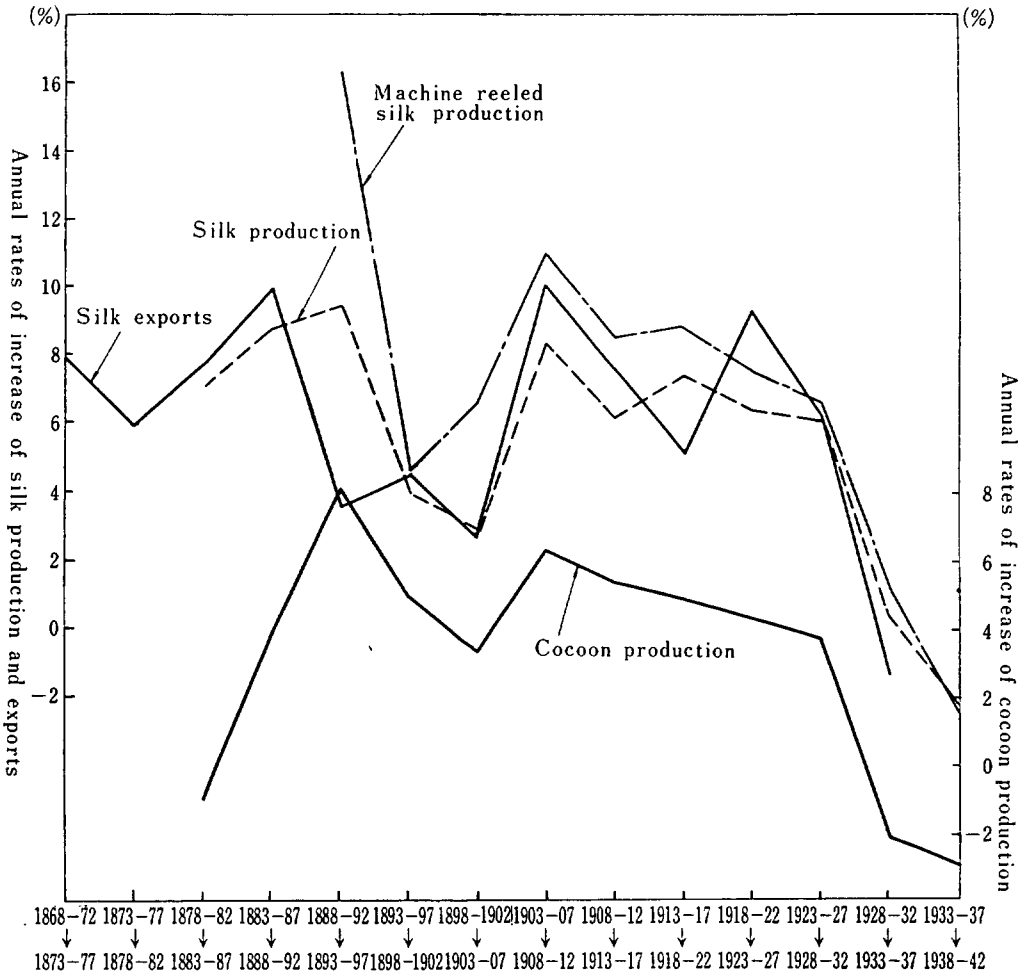
In Chart 6, the second trough (1903–07) of the long cycle in the rates of increase in silk and cocoon production (or exports) precisely coincides with that of the real income growth rate. However, there is no recovery after the world depression of the 1930's, because the proportion of silk in total exports drastically declined, silk having been replaced by synthetic textiles in foreign markets. At the same time, that the growth rate of silk exports increased during the Matsukata deflation can be interpreted to mean that an export drive emerged as a consequence of that unprecedented deflationary policy.

Chart 7 shows the cycles in the growth rates of cotton thread production (and exports) and cotton fabrics exports. In this chart, too, the second and third troughs coincide with those of the real income growth rate. However, in the first trough of the long swing (1883–87) caused by the Matsukata deflation, there is no decline in their rates of increase. The reason for this may be that, because cotton spinning and weaving were then young, growing industries, they were not adversely affected by such forces.

In Chart 8, the rates of increase of pig iron and steel production show no decline during the second trough in the real income growth rate cycle. On the contrary, 1903–07 was a period when steel production attained a spectacular rate of increase (52% per annum) under the impact of the Russo-Japanese War. However, the first trough (the Matsukata deflation) and the third trough (the world depression) in the real income growth rate cycle are clearly reflected in the cycles of the growth rates in pig iron production and imports.

Thus, how rates of increase in the production of individual commodities are reflected in the total index of production depends upon the weighting system and the averaging

Chart 6 *Long Swing in the Silk Reeling Industry*



method (arithmetic or geometric) adopted. The more recent the industrial composition used as a weighting system, the more sharply the growth or change in production of, say, the metal industry is reflected in the total index of production, if there has been a tendency towards heavy industrialization. On the other hand, under the same assumption, the earlier the weighting system adopted, the smaller the rate of increase of total production, because the proportion of food-processing and textiles is dominant and a sharp increase in, say, steel production does not have such a great effect upon the total index of production.

In 1904–05, when the Russo-Japanese War took place, the proportion of iron and steel output in total production was still small, so when the growth rate of textile output, which formed the predominant share of total production, declines, the index of total production naturally reflects this decline. Therefore, the rate of increase of industrial production based upon the Nagoya index (in which 1930 weights are used) does not correctly

Chart 7 *Long Swing in the Cotton Textile Industry*

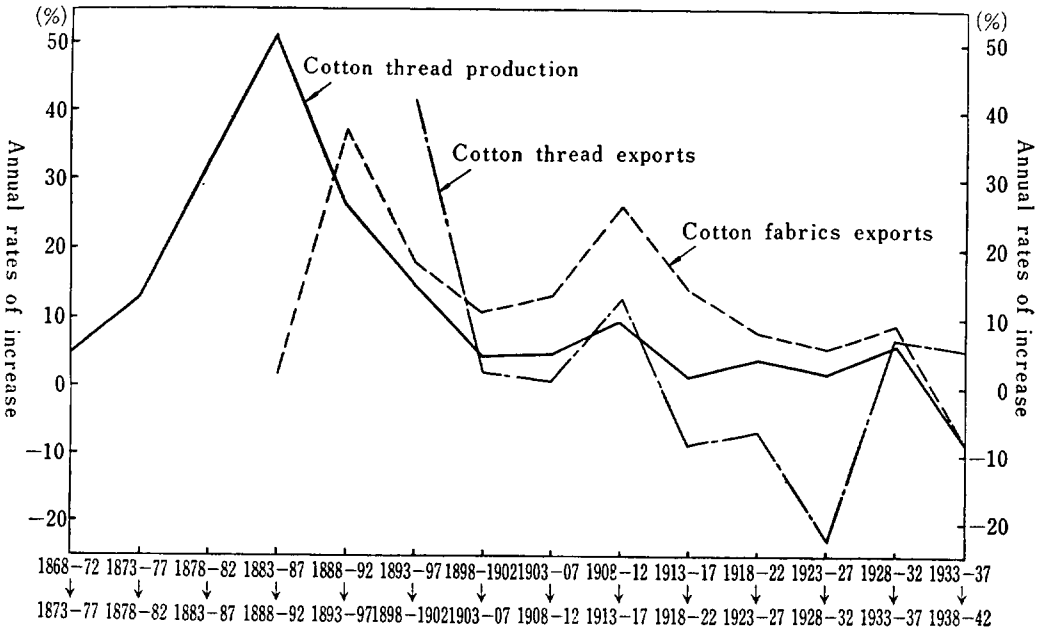
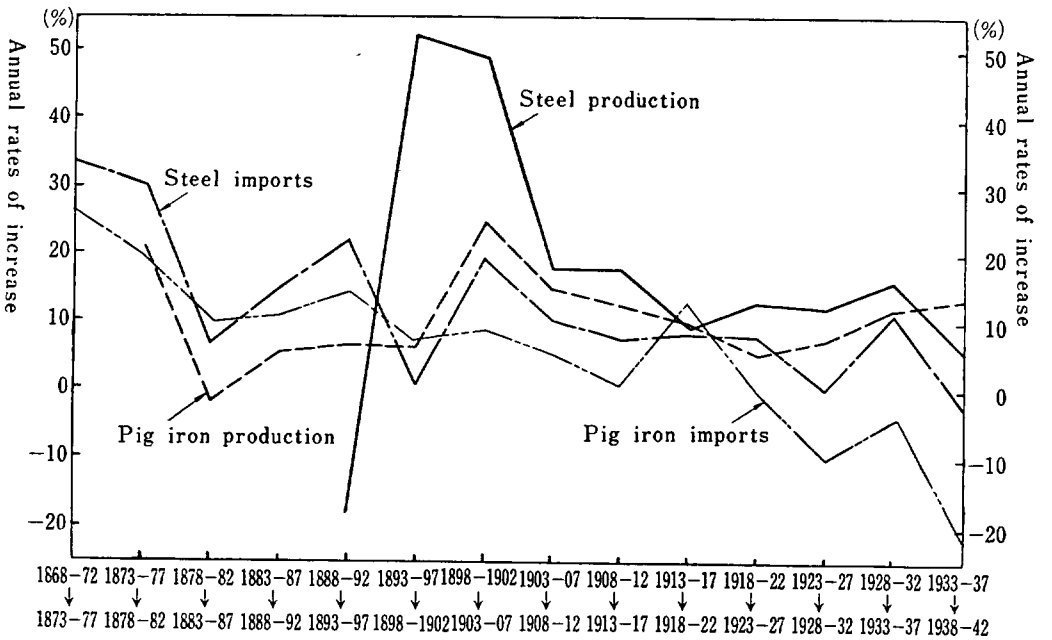


Chart 8 *Long Swing in the Iron and Steel Industry*



reflect cyclical behavior. Moreover, a downward trend of its growth rate would probably be expressed too excessively. If the weight given to light industry were increased, the decline in the industrial growth rate would be smaller. At any rate, it is interesting that the metal-machinery industries and textile-food-chemical industries have mutually opposite effects on the index of total production.

V *Growth Rates by Industry in Different Stages*

It seems that there was no upward or downward trend in the real income growth rate, in the prewar period. However, it can be expected that the growth rates of manufacturing and other basic industries would be considerably greater in the earlier phases of industrialization, and would slow down only in the later stages. The reason this tendency is not reflected in the real income growth rate is that, in the earlier stage, the proportion of rapidly expanding industries was still very small. Therefore, it is necessary to examine growth rates and patterns in greater detail.

Table 2 gives annual output growth rates computed from individual commodity

Table 2 *Growth Rates by Industry in Two Periods*

	Earlier period (A)	Later period (B)	(B—A)
The index of	%	%	%
Industrial production	12.92	8.33	−4.59
Textiles	14.26	7.91	−6.35
Machinery	11.22	7.92	−3.30
Chemicals	19.49	9.87	−9.62
Metals	13.21	10.36	−2.85
Gas, Electricity	16.84	15.11	−1.73
Silk	6.31	5.80	−0.51
(machine-reeled silk)	8.75	7.20	−1.55
Cocoons	3.78	3.75	−0.03
Cotton thread	22.07	4.80	−17.27
Spinning machines (mule plus ring)	18.78	6.92	−11.86
Rayon thread	—	57.39	—
Rayon cloth	—	25.27	—
Paper (Western)	15.39	8.08	−7.31
Tea	0.60	1.97	+1.37
Beer	16.92	7.32	−9.60
Sake	−1.51	0.74	+2.25
Wheat flour	2.87	4.69	+1.82
Cement	(18.05)	10.19	−7.86
Pig iron	9.89	10.54	+0.65
Steel	23.33	14.50	−8.83
Coal	11.69	4.20	−7.49
Electric Power	(30.14)	15.53	−14.61
Rice	2.03	0.91	−1.12
Barley & Wheat	2.17	0.52	−1.65

Notes: 1) With the exception of a few commodities, A period is 1868–72 to 1903–07, and B period is 1903–07 to 1938–42.

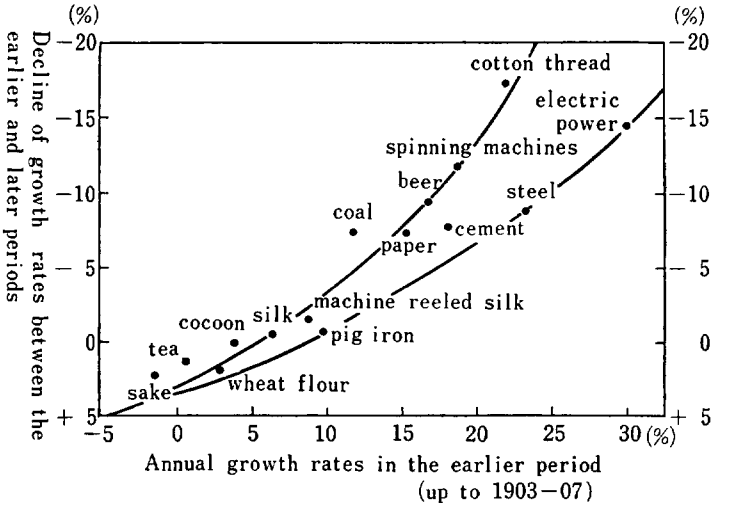
2) In the case of cement (A period), production figures for the entire country are not available, so total cement production by the Asano Cement Co. and the Onoda Cement Co. for 1883–87 was compared with that for 1903–07.
3) Electric power production figures are available only from 1903, but an estimate for 1890 was used in computing the A period growth rate (mentioned in *Nippon Keizai Soran*, p. 863).
4) The Nagoya index was used as an index of industrial production.

production series which are available for a comparatively long period. These rates were computed for an earlier and a later period (mainly 1868–72—1903–07 and 1903–07—1938–52, respectively). Figures for 1868–72 are not available for some of the commodities. In those cases, annual growth rates were comptued by comparing the earliest obtainable 5-year averages with the 1903–07 figure. 1903–07 and 1937–42 were generally compared in computing annual growth rates in the later period, but for a few commodities, lack of data made it necessary to use the 1933–37 average.

Table 2 shows that the higher the growth rate of an industry or commodity in the earlier period, the lower it is in the later period. Tea, sake, wheat flour and pig iron are the few exceptions. For cotton thread and electricity, which have the highest rates of increase in the earlier period, there was a drastic slowing down in the later period. It seems that the "take-loff" stage of industrialization was completed around the earily 1900's, entailing general kinks in the growth curves of various commodities.

The hypothesis that the higher the growth rate of a commodity in the earlier period, the lower it is in the later period is tested in Chart 9. The decline of growth rates (B–A in Table 2) is measured on the vertical axis, and growth rates in the earlier period are measured on the horizontal axis. The hypothesis tests almost perfectly. It may be called as the "law of equalization of growth rates of industries". It should be noted that pig iron, steel and electricity are located on the lower curve of the graph, indicating the tendency of heavy industrialization which interrupted them to fall along the upper line fitted by a free hand in the Chart.

Chart 9 *Tendency of Growth Rates of Industries to Equalize*



VI *Growth Rates of Other Items*

The rapid expansion of Japan's economy seems to depend to a great extent upon the very high rate of growth of exports over a long period. Although the export growth rate declines from the earlier period (7.32%) to the later period (6.69)%, as can be seen from Table 3, the long-term growth rate of exports is very high compared with that of other countries. The growth rate of imports declines from 7.98% to 4.76% for the same periods, so the degree of slow-down is larger for imports than for exports. This difference is largely explained by the drastic deterioration in the terms of trade which occurred during the early 1900's and during the 1930's (the index of the terms of trade given by the Oriental Economist combined with that of the Yokohama Specie Bank: 145.1 (1907), 100.0 (1913), 100.0 (1919), 104.4 (1925), 95.4 (1930). 60.8 (1937). Table 3 also indicates the growth rate of exports of silk, cotton thread and cotton fabric, as a reference.

An important factor which consolidated the basis of the earlier industrialization was investment in social overhead capital. The growth rates for miles of railroad in operation and other transportation indicators, are shown in Table 3. In general, these have an extremely high rates of growth. For example, that for miles of railroad in operation in the earlier period was 16.82% per annum (it declined to 3.95% in the later period).

Table 3 *Growth Rates of Foreign Trade, Transportation and Communication*

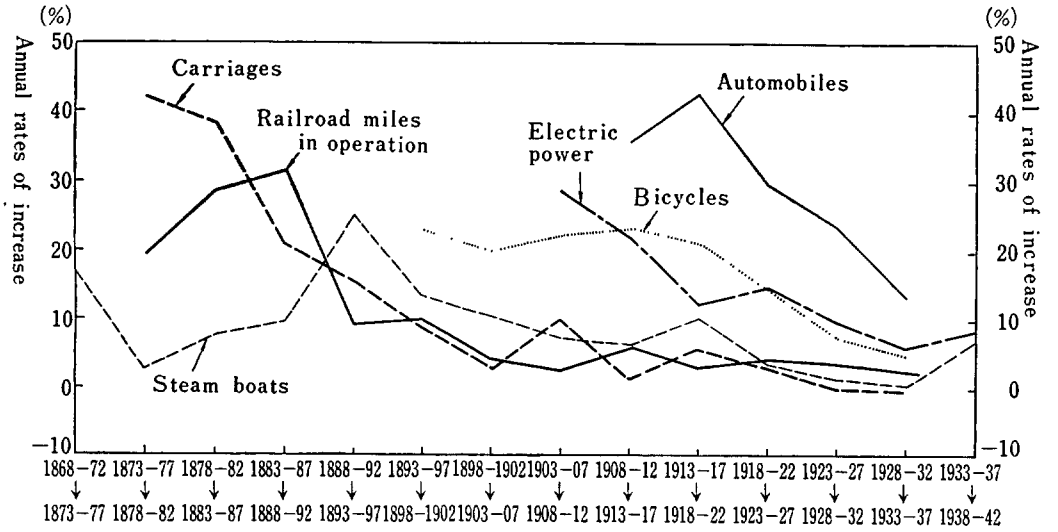
	Earlier period (A)	Later period (B)	(B−A)
	%	%	%
Index of total volume of exports	7.32	6.69	−0.63
Index of total volume of imports	7.98	4.76	−3.22
Exports of silk	6.24	6.60	−0.18
Exports of cotton thread	20.34	−3.54	−23.88
Exports of cotton fabrics	16.38	12.51	−3.77
Miles of railroad in operation	16.82	3.95	−12.87
Total tonnage of steamboats	11.72	5.10	−6.17
Acceptance of ordinary postal matter	13.60	4.76	−8.84
Number of carriages	20.03	3.44	−16.59
Number of carts	8.35	0.43	−7.92
Number of "Rikisha"	1.07	−6.84	−7.91
Number of automobiles	—	28.10	+28.10
Number of bicycles	21.35	15.38	−6.15

Notes: A period: 1868–72 to 1903–07; B period: 1903–07 to 1938–42. However, for cotton thread exports in the earlier period, 1903–07 was compared with 1890–92, and for cotton fabrics exports, 1903–07 was compared with 1883–87. For miles of railroad in operation in the later period, 1933–37 was compared with 1903–07.

The older means of transportation such as "Rikisha", carts and carriages, were replaced to a great extent by the automobile in the later period, although some of them have notably high growth rates in the earilier period. The number of carriages, for instance, showed an annual growth rate of 20.0% in the earlier period. The extremely rapid expansion of transportation facilities and electric power characterized early Japanese industrialization until the early 1900's. Their growth rates increase as they are traced to the earlier

period, as shown in Chart 10. The important role of transportation in the early stage of the Meiji economic development can be recognized from this.

Chart 10 *Changes in Growth Rates of Transportation and Electric Power*



One subject remaining to be discussed is the role played by education. Recently, it has been recognized that low levels of education and technical skill are sometimes intractable bottlenecks to economic development in underdeveloped countries. As a result, there have been attempts to re-evaluate the role of education in the early industrialization of the advanced and semi-advanced countries. The author concurs in the opinion of a foreign economist who pointed out that the early adoption of compulsory education (1879) by the Meiji government laid the foundation for the rapid growth potential of the later Japanese economy. This article does not attempt an overall analysis of the role of education, but only indicates some computational results relating to it.

In the United States, the proportion of the total population enrolled as pupils and students (elementary schools to universities) was 22.6% in 1900, 24.2% in 1930, and 21.1% in 1952. This may be looked upon as a numerical barometer of the level of education in an advanced country. Compared with this, Table 4 shows that the percentage of the population attending schools in Japan reached 24% in 1938–42, indicating the rapidity with which it attained the level of advanced countries in about 70 years. Particularly, it should be noted that, in 1923–27, the percentage was already 19.32%. Of course, such a numberical comparison does not show the quality of education, but it is important as a preliminary reference.

Chart II compares the average annual rates of increase in the number of pupils and students by school category in Japan and the United States using two periods, and Chart 12 depicts this rate in Japan, 1873–1942. According to Chart 11, the annual rates of increase in the number of pupils and students by school category in Japan during the period

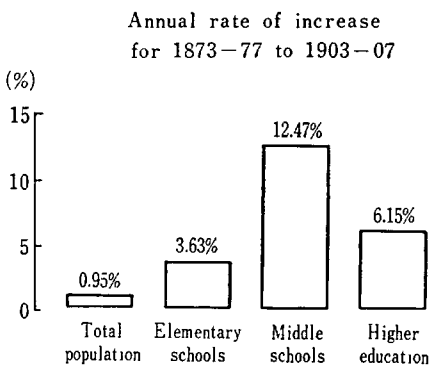
Table 4 *Percentage of Population Attending Schools*

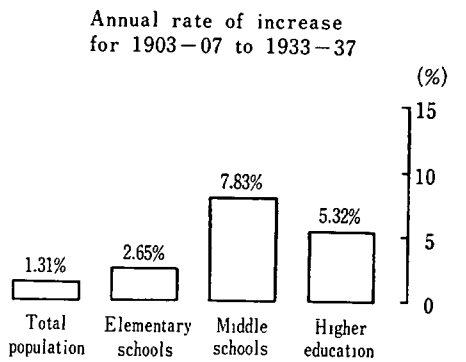
	Total population	Pupils and students		Students in middle schools		Student in higher schools, colleges, and universities	
	thousand	thousand	%	thousand	%	thousand	%
1878–82	36,911	2,589	(7.01)	22.5	(0.06)	7.5	(0.020)
1893–97	41,894	3,815	(9.11)	47.4	(0.11)	15.6	(0.037)
1908–12	49,728	7,413	(14.91)	511.7	(1.03)	47.6	(0.096)
1923–27	59,827	11,561	(19.32)	1,886.4	(3.15)	130.5	(0.218)
1938–42	71,678	17,208	(24.01)	4,226.4	(5.90)	232.9	(0.325)

1903–07—1933–37 are similar to those in the United States during the period 1900–1930. Chart 12 is particularly interesting because the long swing in the rate of increase of students in higher schools, colleges and universities lags five to ten years behind that of the real income growth rate. Therefore, it is clear that long-term changes in the number of students enrolled in higher education have been strongly influenced by the long swing of the real income growth rate.

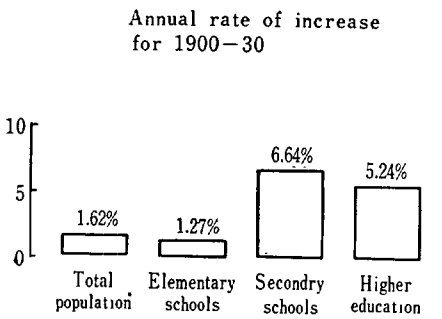
Chart 11 *Comparison of the Rates of Increase of Pupils and Students in Japan and the United States*

[JAPAN]





[U.S.A.]



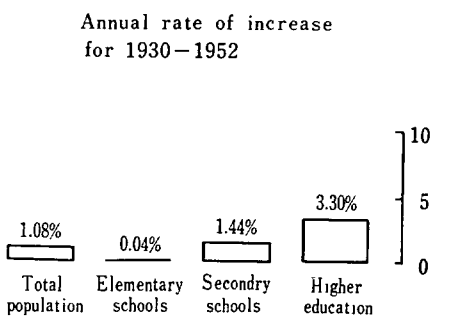
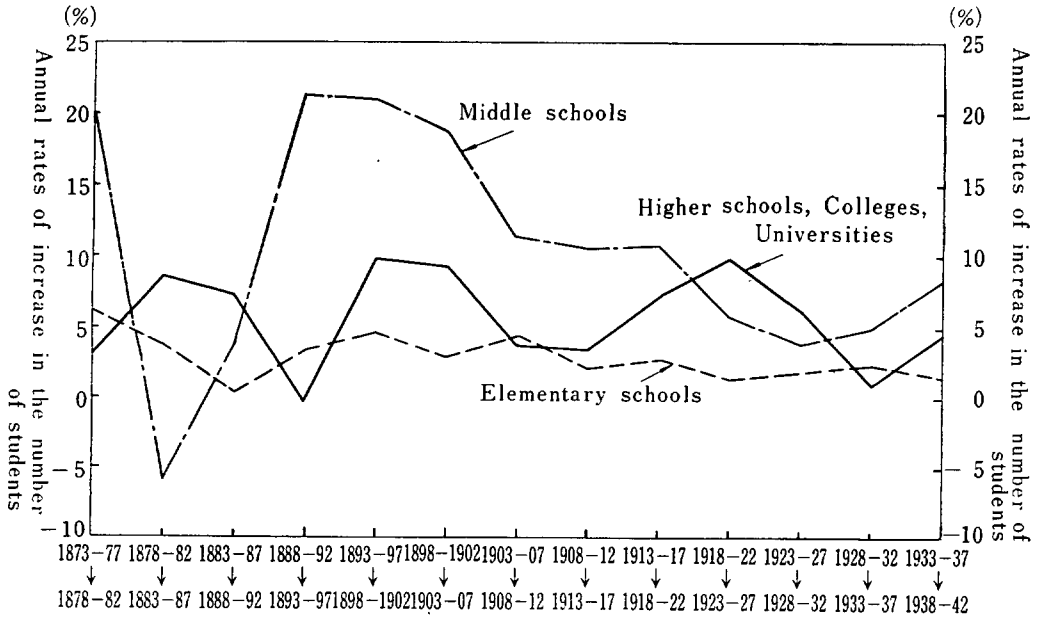


Chart 12 *Long-term Changes in Rates of Increase of Pupils and Students*



VII *The Terms of Trade and the Growth Rates of Exports and Imports Classified by Items of Commodities*

It is this writer's hypothesis that rapid growth of the Japanese economy in the prewar period was strongly supported by the secular deterioration in the terms of trade from the end of the Meiji era. This hypothesis has been the target of strong criticism by K. Kojima, M. Tatemoto and others.[4] However, the writer still believes that the extremely high rate of growth of exports in the prewar period would not have been possible, if such drastic deterioration in the terms of trade had not cocurred, whether this came about through export drive (or exchange devaluation) or the sharp rise of comparative productivity in the export industry. In other words, the rapid expansion of exports could not have taken place only as a result of increase in world income. Even in the 1930's when world exports were severely stricken by the great depression, Japanese exports experienced a spectacular expansion. Thus, the strong push through the terms-of-trade effect upon exports should be reconsidered. Of course, this is merely a "strategic" emphasis of a point which has been neglected in explaining the development of Japan's exports and production. This thesis will be bolstered by adding a new analysis in this paper.

The foreign trade index given in the Oriental Economist, which hitherto has been the only long-term index available, lacks detailed breakdowns. Therefore, Mr. Katsumi

[4] Recently, the articles concerning this controversy were compiled in a book: K. Kojima (ed.), *Ronso: Keizai Seicho to Nihon Boeki* (The Controversy over Economic Growth and Foreign Trade in Japan), Tokyo, 1960. See also an article in English by K. Kojima, "Japanese Foreign Trade and Economic Growth: With Special Reference to the Terms of Trade", *Annals of the Hitotsubashi Academy*, April 1958. However, I do not believe that my thesis is presented in his paper as I originally formulated it.

Yamada, my colleague, has computed a new index beginning in 1900, from which time a drastic decline of terms of trade occurred. The analysis made here depends largely upon the new data he presents. Computation of the rates of growth in exports and imports of various commodities from 1903–07 to 1933–37 shown in Table 5 was made on the basis of his figures.

Considerable differences in the export and import growth rates of various commodities can be seen in Table 5. These differences can be explained to a large degree by the differences in changes in the terms of trade. Chart 13 (A) shows that there is an interesting inverse correlation between export growth rates and changes in the terms of trade clas-

Table 5 *Annual Growth Rates of Exports and Imports by Commodity*
—1903–07 to 1933–37—

	Growth rates of imports	Growth rates of exports
	%	%
Total	4.76	6.69
1. Animals and plants	−3.63	4.37
2. Food, beverages and tobacco	1.14	5.03
2.1 Cereals and seeds	1.13	6.31
2.2 Vegetables and fruits		3.33
2.3 Other foods		5.49
2.4 Liquors and tobacco	2.13	0.11
3. Thread, fabrics and apparel	4.17	7.47
3.1 Thread and cotton cloth	5.22	5.75
3.2 Fabrics	−7.08	10.36
3.3 Other cloth goods	−6.05	5.68
3.4 Apparel	−8.16	9.36
4. Leather, bones and hair	2.97	5.44
5. Oils, fats and chemicals	7.75	5.45
5.1 Oils and fats	5.82	7.08
5.2 Inorganic chemicals	7.69	4.34
5.3 Organic chemicals	12.10	
5.4 Dyestuffs and cosmetics	−0.53	11.81
6. Nonmetallic minerals, metals and metal products	7.51	5.66
6.1 Nonmetallic minerals and their products	9.72	0.46
6.2 Glass and clay products	−0.04	7.61
6.3 Iron ore and other ores	13.59	4.75
6.4 Iron and steel	4.88	
6.5 Nonferrous metals	7.75	
6.6 Metal products	3.71	12.24
7. Machinery	3.41	4.30
8. Timber and wood products	11.14	4.04
9. Others		
9.1 Miscellaneous products	3.89	4.52
9.2 Paper and paper products	0.67	7.23

Sources: 1) Katsumi Yamada, "Prewar Foreign Trade Index" (General Report, B. 25) and (Report by Commodities, B. 37), mimeographed, in Japanese. These are a part of the reserach of the Inst. of Ecom. Research of Hitotsubashi University supported by the Rockefeller Foundation.

2) In the K. Yamada index, the price index is derived on the basis of 1928–30 weights. The quantity index is derived by deflating the value index by the price index.

sified by commodity during the period 1903–07 to 1933–37. The greater the deterioration in the terms of trade, the higher export growth rate, and vice versa. In Chart 13 (B), import growth rates and changes in the terms of trade for various commodities are compared. In contrast to the case of export growth rates, a positive correlation is obtained. For those commodities with favorable changes in the terms of trade, import growth rates are also higher. Thus, export and import growth rates are presumed to have been highly elastic to changes in the terms of trade by commodity.

Chart 13 *The Relationship between Terms of Trade and Export and Import Growth Rates by Commodity*

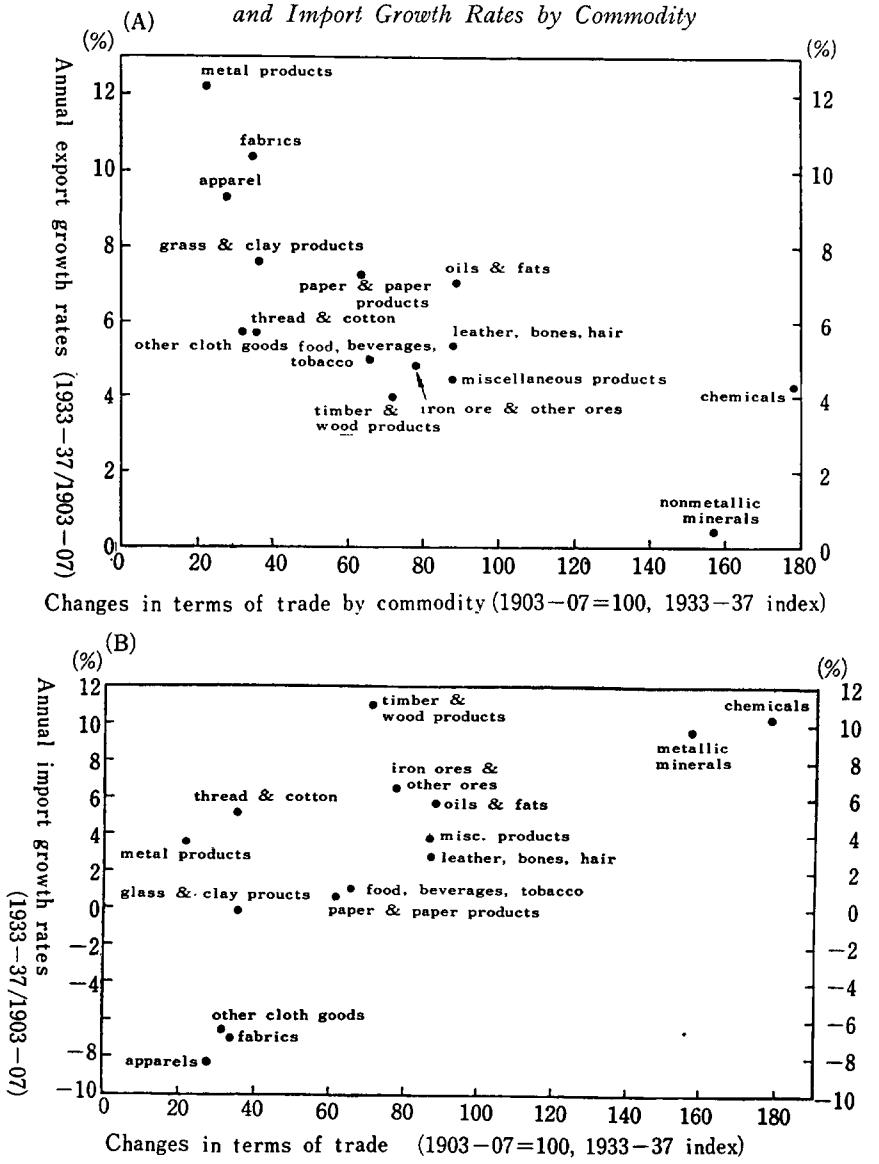


Chart 14 *The Relationship between Export and Import Prices and Their Growth Rates by Commodities*

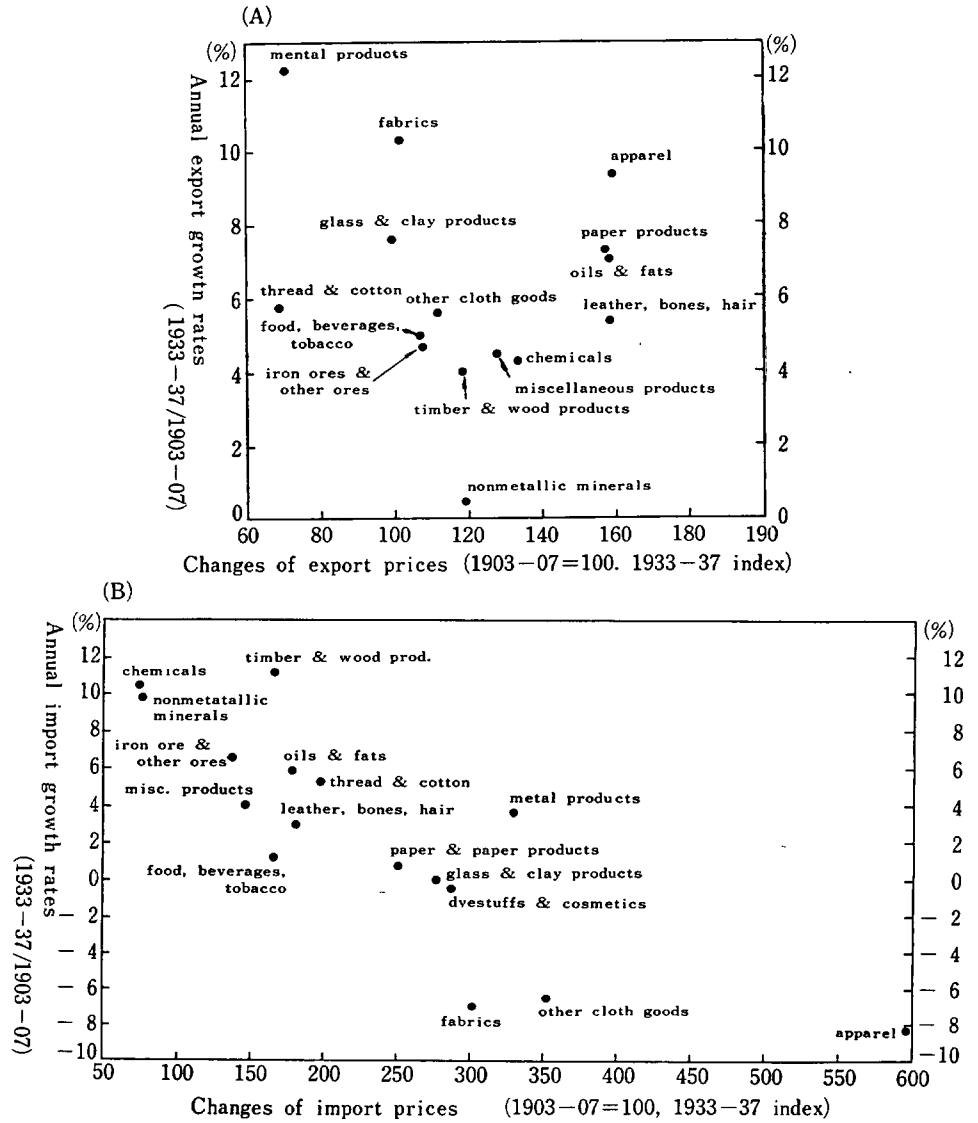
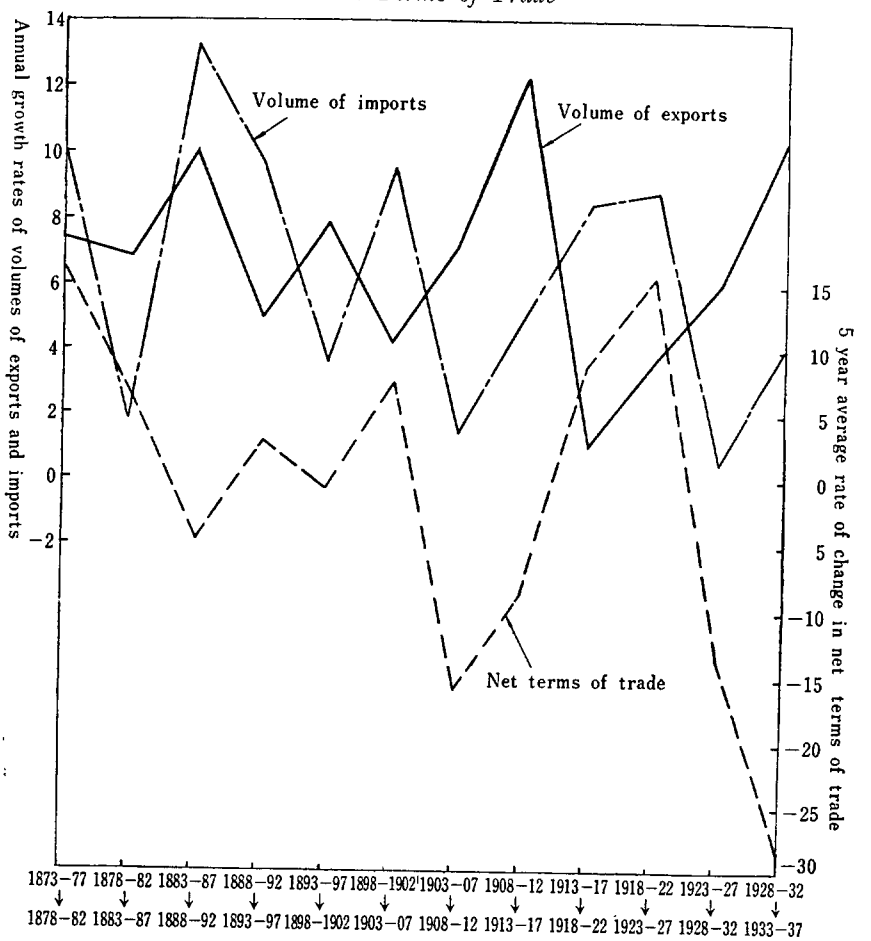


Chart 14 (A) and (B) measure changes in export and import prices, respectively, instead of changes in terms of trade on the horizontal axis. As a result, in Chart (A), in which export growth rates are measured on the vertical axis, there is no clear correlation between the two. However, in Chart (B), there is a fairly nice correlation. The reason for this is as follows. In explaining the influence of export prices, the behavior of foreign export prices is also relevant, so variations in domestic prices alone are inadequate to explain differences among export growth rates of various commodities. In explaining the effect

of import prices, only changes in foreign prices are relevant, provided domestic prices are given. The fact that imported goods are often not produced domestically is, at the same time, the reason a good correlation is obtained in the case of Chart (B).

The terms of trade effect in the case of exports and imports of individual commodities has been shown above. Then, do the terms of trade have any bearing on variations in total exports and imports? Chart 15 gives the annual growth rates of exports and imports, on the one hand, and the five-year average rate of change in the terms of trade, on the others. Excluding the two periods, 1883–87 to 1888–92 and 1928–32 to 1933–37, the cyclical fluctuations of the import growth rate and changes in the terms of trade are perfectly parallel. The first exceptional period in which the variables are inversely related (1883–87 to 1888–92), can be interpreted as one in which imports, suppressed by the Matsukata deflation, reacted sharply when the deflation ended. The inverse correlation during the period 1928–32 to 1933–37 can also be easily understood as a consequence of the beginning of a war economy.

Chart 15 *Total Export and Import Growth Rates and Changes in the Terms of Trade*



Except for two periods, there is an inverse relationship between the export growth rate and changes in terms of trade. In one of the periods, 1908–12 to 1913–17, a favorable change in the terms of trade could coexist with the rise of exports because of the influence of World War I. The second exception, 1918–22 to 1923–27, was a period of post-war reconstruction in European countries, so favorable terms of trade and a rise in the export growth rate could again coexist.

The above analysis of the effect of the terms of trade with respect to aggretage mannitudes as well as individual commodities ,supports this writer's hypothesis concerning the role of the terms of trade. Of course, Chart 16 completely neglects the income effect, and merely compares price-quantity relationships. In this regard, some computations of export and import functions made during the author's controversy with Masahiro Tatemoto are presented.

Denoting exports by x, world real income by y_w, and the terms of trade by π, Mr. Tatemoto has computed the following export function for 1924–37.

$$\left.\begin{array}{c}\log x=4.4547-1.5754\log\pi+0.3629\log y_w \\ \mathrm{R}=0.974\end{array}\right\}\cdots\cdots\cdots\cdots\cdots\cdots(1)$$

The author computed the function using relative export prices (compared with world prices), p_x/p_w, instead of the terms of trade.

$$\left.\begin{array}{c}\log x=1.7981-1.0563\log(p_x/p_w)+1.1750\log y_w \\ \mathrm{R}=0.9689\end{array}\right\}\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

It is interesting that price elasticity in the export function in both computations is very high, exceeding unity, although the income elasticity in (1) seems too small.

On the other hand, the import function computed by the author for the same period, in which real domestic income is money national income deflated by the cost-of-living index, is as follows. Denoting imports by m, domestic real income by y, and relative import prices by (p_m/p),

$$\left.\begin{array}{c}\log m=1.06101-0.19149\log(p_m/p)+0.67145\log y \\ \mathrm{R}=0.9121 \\ m=57.760-0.19901(p_m/p)+0.67183\,y \\ \mathrm{R}=0.9730\end{array}\right\}\cdots\cdots\cdots\cdots\cdots\cdots(3)$$

In this import function, price elasticity is about 0.2, much smaller than that in the export function.

The sum of the two price elasticities (1.575 or 1.056+0.191 or 0.199) exceeds unity, satisfying the so-called "Lerner's condition". Therefore, deterioration in the terms of trade would be effective in adjusting the balance of payments in deficit. The potential deficit which would have occurred under constant terms of trade as the result of a higher income growth rate relative to other countries, would be wiped out by deterioration of the terms of trade, provided the sum of the two price elasticities exceeds unity.

It is interesting that the terms of trade deteriorate just after the long swing in the real income growth rate reaches a trough. They deteriorated by 31% in 1907–13, and by 40% in 1931–37. To repeat, the change to the gold standard, the occurrence of a trough in the world Kondratieff cycle and other factors mentioned in discussing the long swing characterized the second trough of the long swing in Japan. These factors together with the rise in comparative productivity of the cotton textile industry (as an export industry)

through the industrial revolution in the early 1900's, had a strong bearing upon the succeeding deterioration of the terms of trade. The second deterioration in the terms of trade also occurred after a trough (the third) of the long swing, as a result of the unprecedented exchange devaluation in 1932.